ELEC 241: Fundamentals of Electrical Engineering I

The course's objectives are to provide, through homework and tutorials, the technical foundations for succeeding courses in electrical engineering and, through the laboratory, the practical foundations.
Prerequisites: Math 101, 102.

Course Outline

Elements of signal and system theory

- Digital and analog information
- Block diagrams: sources, systems, sinks

Signal and system analysis

- Analog
  - Signal theory: time-domain concepts of amplitude, delay, superposition
  - Representation of signals by electronic quantities (electric, optical)
  - Elementary circuit theory
    - Circuit laws; series and parallel configurations
    - Power dissipation
    - Equivalent circuits
    - Impedance
    - Basic analog circuit building block: the op-amp
  - Frequency domain counterpart for signals
    - Fourier series; signal decomposition; notion of bandwidth
    - Sampling theorem
- Digital
  - A/D conversion; amplitude quantization; data rate
  - Discrete-time signals and systems

Information Transmission

- Analog (AM) communication
  - Modulation and demodulation
  - Noise (SNR, WGN)
  - Linear filters for noise reduction
- Digital communication
  - Entropy and Shannon's Coding Theorem
  - Lossless and lossy compression; redundancy
  - Channel coding; error correcting codes; transmission rate
  - Capacity; Shannon's Noisy Channel Coding Theorem

Fundamentals of Communication System Design

- Sending signals over noisy, bandlimited channels
- Tradeoffs in analog and digital communication choices

Course Objectives

1. Mathematically describe and manipulate complex exponential signals and linear, time-invariant systems that operate on them;
2. Apply Kirchhoff's Laws, equivalent circuit models, and transfer functions to analyze voltage and current relationships in passive circuits;
3. Apply formal node analysis to analyze the operation of basic op-amp circuits;
4. Use Fourier series representation of periodic signals to perform frequency domain analysis of linear time-invariant systems;
5. Apply properties of the Fourier transform to describe and analyze the operation of Amplitude Modulation (AM) for communicating information;
6. Specify how to encode and recover a bandlimited signal with a digital sequence using the sampling theorem and amplitude quantization;
7. Analyze the behavior of digital systems on discrete-time signals using the Discrete-Time Fourier Transform (DTFT);
8. Calculate the complexity of implementing discrete-time filtering using the Fast Fourier Transform; describe and analyze discrete-time filtering of analog signals;
9. Describe the operation of baseband and modulated communication systems, and analyze the signal-to-noise ratio of AM systems;
10. Explain the use of binary phase-shift keying (BPSK) for communicating digital information with analog signals, and performance of BPSK in the presence of noise;
11. Construct simple source compression codes and error-correcting codes, and explain their application in digital communication of information;
12. Use Shannon's Source Coding and Channel Capacity Theorems to compare the tradeoffs between using digital and analog methods for communicating information.

Required Texts

Johnson and Wise, *ELEC 241*, Connexions course pak
Wise and Johnson, *ELEC 241 Laboratory Manual*
A lab notebook will be required for each lab group.

Grading Policy

Grades are based on three quizzes, the homework, the laboratory, and a final.

- Weekly homework sets will be graded for credit *only* if turned in by the due date. Understanding and solving the problems on the homework sets may be performed in groups, especially in problem sessions, but each student should prepare his/her solutions individually.
- Laboratory notebooks must be maintained, and these will be graded. A formal report will be required for the final laboratory.
- The final is a take-home final held during finals period.

Homework and laboratory grades will be separately averaged and normalized to a 100 maximum, the grading standard for quizzes and the final. One problem on the final relates to material covered in the first quiz. The greater performance, whether on Quiz 1 or on this section of the final, will become the first quiz's grade. All other quiz grades stand, and are included in the determination of the course average in the usual way.

Quizzes	3 (1 each)
Homework	1
Laboratory	1
Final	2
Total	7